SYSTEM FOR CORRECTING BIOLOGICAL FLUIDS

BIOLOGICAL FLUID CORRECTION SYSTEM

SPHERE OF TECHNIQUE

BACKGROUND OF THE INVENTION
Field of the Invention

The inferred invention pertains to biology and medicine and might be applied for biological fluids purification and normalize condition of those to physiological standards.

TECHNIQUE PRECEDING LEVEL

Discussion of Related Art

There is a known facility for biological fluids correction (refer to e.g. International Bid № PCT/RU94/00022, IPC: A 61 M 1/36, 1994), consisting of a biological fluid mixing compartment (further as mixing chamber) with ferreed sorbent being in e.g. a physiological solution; a compartment for precipitation of ferreed sorbent out of the biological fluid using magnets after their (the fluid and the ferreed sorbent) interaction (further as precipitation chamber), a vessel for ferreed sorbent with the physiological solution (further as vessel), and a driving gear ensuring the facility operation. The mixing chamber is connected with the vessel and the precipitation chamber by channels through a filtering device connected to the correction facility outlet socket, by inlet socket linked to biological fluid inflow source, e.g. to patient's vein. Here the inlet socket in connected with the mixing chamber through a channel, while the vessel outlet channel is input into the same channel, and furthermore, valves enabling the biological fluid flow from the inlet socket to the outlet socket of the facility are installed in the channels.

The known facility/equipment enables the possibility of biological fluids correction through removal of e.g. low-molecular and medium-molecular toxins,

however, the above known equipment application requires immixture of the fluid being corrected with physiological solution, as well as infusion into the biological fluid (e.g. into blood) of anticoagulants, which is not always indicated for the patient. Besides, constructive performance of the equipment is quite sophisticated.

The closest One analogous prototype equipment to the above described facility is the biological fluids correction system taught by U.S. (refer to e.g. USA Patent № 5,980,479 IPC: A 61 M 37/00, with priority of Jul. 02, 1997), containing a hermetical mixing chamber, a precipitation chamber and a vessel for the ferreed sorbent, at that the . The mixing compartment is connected via hose channels with the vessel and the correction chamber through a filtering device connected to the correction system outlet socket, by an inlet socket linked to the biological fluid inflow source, e.g. to a patient's vein. Biological fluid flow from the inlet socket to the outlet socket of the system is ensured by the pumps installed on the channels, here the . The inlet socket is connected with the mixing chamber via a channel and the vessel outlet channel is input in the same channel. Besides, Also valves controlling the biological fluid specified flow direction are installed in the channels, and the vessel is equipped with has a device for maintaining the predetermined pressure.

Such system enabler enables the possibility of biological fluid correction, however, it does also have the same abovementioned disadvantages of the previous previously described equipment, and besides, in order to avoid any occasion of ingress of air into the biological fluid being corrected, which air is used for e.g. maintaining the predetermined pressure in the vessel with ferreed sorbent in physiological solution, the system construction is substantially complicated, e.g. the device filtering the already processed

fluid before getting out of the system is too much sophisticated.

INVENTION DISCLOSURE

The invention of «Biological Fluid Correction System» is based on the objective to develop a technical solution enabling to perform biological fluid purification at minimal input of foreign (extraneous) reagents into the fluid being corrected.

The assigned task is achieved by enabling the fact that in the biological fluid correction system consisting of the following hermetic parts, connected via channels with valves installed in those channels for providing flow of the biological fluid through the system from the inlet socket to the outlet socket: a vessel for ferreed sorbent, chambers for mixing of ferreed sorbent with the biological fluid and precipitation of the ferreed sorbent out of the fluid, and a filtering device connected through the system outlet channel with the outlet socket, linked to the system inlet channel. The mixing chamber, the ferreed sorbent precipitation chamber and the vessel for ferreed sorbent are performed with an ability to change their volumes and are equipped with a corresponding driving gear, here the chambers for mixing of ferreed sorbent with the biological fluid and for ferreed sorbent precipitation out of the biological fluid are made in the form of vessels having either rigidly connected covers, or one common lid, as well as one common wall mounted to the bottom of those chambers and made as an interchamber partition, here the chamber inner cavities are connected via the channel installed in the partition, while the other side walls of the chambers have bumps constituting corresponding silphons, and the chamber lids are fixed on the interchamber partition via hinges; here the vessel for ferreed sorbent is installed inside the chamber for mixing ferreed sorbent with the

biological fluid and made in the form of e.g. cylinder with silphon-looking bumped side surface, while one butt-end of the cylinder is fastened to the bottom of the chamber for mixing ferreed sorbent with the biological fluid, and the other butt-end is equipped with a lid fastened in the chamber lid, here magnets are installed on the bottom of the chamber for ferreed sorbent precipitation and the system inlet socket is simultaneously connected with both the mixing chamber inner cavities and the vessel for ferreed sorbent connected with the mixing chamber inner cavity.

Furthermore, the mixing chamber and the ferreed sorbent precipitation chamber lids are connected or performed either being positioned on one level, or in the form of V-shaped in section profile, and the corps formed by those mixing and precipitation chambers in plane is made e.g. as either a rectangle with round corners, or in the form of circle, or in the form of ellipse, or in the form of figure-of-eight and at that volumes of the ferreed sorbent mixing and precipitation chambers inner cavities are chosen in the proportions of either 1:1, or 1:(0,1-0,9), or (0,1-0,9):1 and correspondingly, a volume of the ferreed sorbent mixing chamber inner cavities and volume of the ferreed sorbent vessel are chosen in proportion of 1:(0,1-0,9), and besides, the ferreed sorbent vessel in instilled inside the ferreed sorbent mixing chamber at the distance of at least (1-100)d from the side wall of the chamber and at least (10-100)d from the partition between the mixing and the precipitation chambers, where **d** is the inner diameter of the channel connecting the system inlet socket with the ferreed sorbent mixing chamber inner cavity.

At that the channel from the inlet socket is input into the ferreed sorbent mixing chamber either through the chamber bottom or through the chamber lid, the

channel from the inlet socket is input into the mixing chamber at the angle of (10-80)° to the bottom level, or, correspondingly, to the chamber lid and the vertical line; the channel from the inlet socket is input into the vessel for ferreed sorbent through the vessel lid or its bottom, and the outlet channel from the ferreed sorbent vessel into the ferreed sorbent mixing chamber is installed e.g. in the lower part of the vessel side wall at the distance of (0,5-50)d from the chamber bottom, where **d** is the channel diameter.

Furthermore, the channel between the ferreed sorbent mixing and precipitation chambers is installed in the partition between the chambers at the distance of (0,5-50)d from the chambers bottom, where **d** - channel diameter, and the outlet channel from the ferreed sorbent precipitation chamber is installed in the upper part of the chamber side wall at the distance of (0,5-50)d from the lid, where **d** – channel diameter.

At that the magnets are installed either inside of the ferreed sorbent precipitation chamber, or outside of the chamber, or they are installed inside and outside the chamber and are fixed on the bottom of the ferreed sorbent precipitation chamber.

Furthermore, the driving gear for changing volumes of the mixing and precipitation chambers and the vessel is made in the form of e.g. electric motor connected with the lid through e.g. a reduction gear or a tappet gear; or else it is made in the form of a reduction gear fixed on the output shaft, e.g. at the angle of (30-45)° to the disc shaft axis, while rotation of the shaft alternatively interacts with chamber lids, or else it is made in the form of tappet gear connected with the lid, operating with the possibility of operator's manual action, or the above driving gear is performed with the possibility of operator's manual action directly to the lid.

At that, the spot above the mixing chamber corrugated side wall or the spot above the precipitation chamber corrugated side wall were chosen as the operator's action application spot.

Furthermore, the diameters of input channels going into the ferreed sorbent mixing chamber and the vessel are made in the proportion of $d/di=V/V_b$ where d – inner diameter of the input channel going into the mixing chamber, dj - inner diameter of the input channel going into the vessel, V- mixing chamber, V_r – vessel capacity.

Here the walls of the vessel and the mixing and precipitation chambers, as well as the interchamber partitions, the lid and the bottom are made of e.g. polyurethane, and the corrugation is performed at (0,5-0,95) of the respective walls' height.

BRIEF DESCRIPTION OF THE DRAWINGS FIGURES

The biological fluid correction system scheme is shown in the Figure 1; the system filtering device scheme is shown in the Figure 2; the system view with V-shape-connected lids is shown in the Figure 3; the capacity change driving gear scheme variation is shown in the Figure 4; the system chambers bottom hinged fastening scheme is shown in the Figure 5; variations of the system performance in plane in the forms of a circle, an ellipse or a figure-of-eight, correspondingly, are shown in the Figures 6-8.

THE BEST VARIATION OF THE INVENTION EMBODIMENT

The biological fluid correction system consists of (Fig. 1) a vessel 1 for holding the biological fluid intended for purification, e.g. patient's blood out of e.g. ferreed sorbent low-molecular and medium-molecular toxins, not shown in the Fig.1, refer to e.g. International Bid № PCT/RU94/00022, IPC: A 61 M 1/36, 1994, performed

in the form of a cylindrical silphon, installed in the chamber 2 for mixing of ferreed sorbent with the biological fluid, designed for providing interaction of ferreed sorbent with the above fluid; here the silphon is performed at cost of part of the cylinder being made as respective corrugation ruffles (not numbered on the Figure), and the corrugation is made at (0,5-0,95) of the cylinder surface height. The vessel 1 is fixed on the bottom 3 of the ferreed sorbent mixing chamber 2 with one butt-end (not numbered in the Figure), which has no corrugation alongside, and the vessel other butt-end is fixed on the lid 4 of the mixing chamber 2 and hermetically sealed with the lid 5.

The bottom 3 of the mixing chamber 2 is connected via rigid fastening (Fig. 1) or hinged fastening (Fig. 7) with the wall 6, functioning as a partition between the mixing chamber 2 and the precipitation chamber 7, designed for the ferreed sorbent liberation out of the biological fluid; here the lid 4 of the mixing chamber 2 and the lid 8 of the precipitation chamber 7 are rigidly connected among themselves and installed on the wall 6 via the hinge 9 with the ability to swing around it in plane, perpendicular axe (not shown in the Figure) of the hinge. At that the lids 4 and 8 are placed in either one plane (Fig. 1), or at an angle, e.g. in the form of V in section (Fig. 3), while the lids sizes in the above section (V-shape sides sizes) and, correspondingly, the in-between angle size are chosen in view of providing the requested proportion of capacities of chambers 2 and 7, and the hinge axe 9 is placed right in the junction of those sides. The bottom 10 of the precipitation chamber 7, as well as the bottom 3 of the mixing chamber 2, is connected via rigid fastening (Fig. 1) or hinged fastening (Fig. 7) to the wall 6. The outer walls 11 and 12, respectively, of the mixing chamber 2 and the precipitation chamber 7, are

formed [performed] as corrugated silphons, and here the corrugation in the ferreed sorbent vessel 1, as well as in the chambers 2 and 7 for ferreed sorbent mixing and precipitation, is made at (0.5-0.95) [(0,5-0,95)] of the respective [walls] wall height.

The bottoms 3 and 10, the lids 4, 5 and 8, and the walls 6, 11 and 12 of the chambers 2 and 7 for ferreed sorbent mixing and precipitation respectively, as well as the walls (not numbered in the Fig. 1) of the vessel 1 are made of non-magnetic materials, e.g. of polyurethane.

Magnets 13 are installed in the bottom 10 of the precipitation chamber 7. The [those] magnets 13 are performed as e.g. a permanent magnet from samarium (8t)-cobalt (Co) alloy, functioning for educing the ferreed sorbent out of the biological fluid [at that the above]. The magnets 13 depending on e.g. design considerations or in order to get the magnetic field of the specified capacity, might be installed either inside of the precipitation chamber 7 under a metal gauze (not shown in the Fig.), or outside on the bottom 10, or both inside and outside the chamber, at that the created by magnets magnetic field capacity should be equal to (10-200) mTl. The example described (Fig.1) demonstrates one installation of the magnets 13 both inside the chamber 7 on the bottom 10, and outside of the bottom 10 of the precipitation chamber 7.

The vessel 1 for the ferreed sorbent and the mixing chamber 2, constructed as e.g. hose channels 14 and 15 through the socket 16 installed on the lid 5 of the vessel 1 and through the socket 17 installed on the bottom 3 (Fig.1) or on the lid 4 (not shown in the Fig.) of the mixing chamber 2, respectively, simultaneously are connected to the biological fluid correction system inlet socket 18 [, here] the socket 17 is installed with a . Here,

possibility of input into the mixing chamber 2 at the angle of (10-80) to the bottom 3 level or, respectively, to the lid 5 and e.g. to the wall 6, in order to provide the fluid flow swirling and its better immixture with the ferreed sorbent.

A channel 19, which is designed for the ferreed sorbent transferring into the mixing chamber 2, is made alongside with the side-wall butt-end of the vessel 1, fixed onto the bottom 3 of the mixing chamber 2.

The channel 20 going from the mixing chamber 2 to the precipitation chamber 7 and the channel 21 going from the precipitation chamber 7 to the filtering device 22, respectively, are installed (as follows: by placing the channel 20 [is placed] in the interchamber partition or [wall 6] alongside to its junction with the bottom 3 of the mixing chamber 2 at the angle of (10-60) to the bottom 10 of the precipitation chamber 7 and to the wall 6; the channel 21 is placed in the upper wall 12 of the precipitation chamber 7. The [At that the] filtering device 22 is connected with the system outlet socket 24 via the channel 23.

In order to provide directed flow of the biological fluid from the inlet socket 18 through the system to the outlet socket 24, the reverse valves 25 are installed in the system channels.

The filtering device 22 is performed (Fig. 2) in the form of the respective device [(refer to e.g. abovementioned USA] Patent [№] 5 980 479), such as taught by U.S. [consisting of] including a sequentially installed ultra-filterer 26 and trap 27 (refer to the above), designed for cleansing the biological fluid out of any therein mixed [in there] foreign/extraneous liquids, e.g. water drops [; and of] or air bubbles, [at that faucets] 30 are installed on the [ultra-filterer] ultra-filter inlet . Faucets

and bypass channels 28 and 29, correspondingly; those faucets in case of need ensure the possibility of ultra-filterer 26 activation and its inclusion to the biological fluid correction system operation, as well as its respective deactivation; here the bypass channel 29 is included for the purposes of providing the system operation in the mode of deactivated ultra-filterer 26.

At that capacities of the inner cavities of the mixing chamber 2 and the precipitation chamber 7 are designed in proportions of either 1:1, or 1:0,1-0,9, or 0,1-0,9:1 and respectively, capacities of the inner cavities of the mixing chamber 2 and the vessel 1 are designed in the proportions of 1:0,1-0,9, and, besides, the vessel 1 is installed in the mixing chamber 2 at the distance of at least (l-100)d from the side wall 11 of the above chamber and at least (10-100)d from the interchamber partition 6, where d – the inner diameter of the channel 15 connecting the system inlet socket 18 with the inner cavity of the mixing chamber 2. In the example described above the d = (5-15) mm.

At that the inner diameters of the inlet channels 15 and 14 (going into the mixing chamber 2 and the vessel 1, respectively) are designed in the proportion of $d/di=V/V_b$, where d – the inner diameter of the channel 15 going into the mixing chamber 2; di – inner diameter of the channel 14 going into the vessel 1; V- the mixing chamber 2 capacity; Vp – vessel 1 capacity. In the example described above the Vi = (5-50) ml.

Furthermore, the output channel 19 going from the vessel 1 into the mixing chamber 2, is installed e.g. in the lower part of the vessel side wall at the distance of (0,5-50)d from the bottom of the chamber, where d – diameter of the channel 19; while the channel 20 between the mixing chamber 2 and the precipitation chamber 7 is installed in

the partition 6 between those chambers at the distance of (0,5-50)d from the bottom 3 of the mixing chamber 2 at an angle of (10-60)° to the planes of the wall 6 and the bottom 10, where d –inner diameter of the channel 20; and the outer channel 21 going from the precipitation chamber 7 is installed in the upper part of the side wall 12 of the precipitation chamber 7 at the distance of (0,5-50)d from the lid 8, where d – inner diameter of the channel 21. In the example described above, diameters of the channels 15, 19, 20, 21, 23, 28 and 29 are designed equal.

The driving gear (not shown in the Fig.) for changing capacities of the chambers 2 and 7, and the vessel 1, is made in the form of e.g. electric motor (not shown in the Fig.), connected with the lid 4 or 8, e.g. through a reducing gear with a tappet mechanism (not shown in the Fig.), or in the form of a disc 31, fixed on the reducing gear output shaft (not shown in the Fig.), e.g. at the angle of (30-45)° to the shaft axe (Fig. 4), at the shaft rotation alternatively interacting with the chamber lids, or else in the form of a tappet mechanism connected with the lid (not shown in the Fig.), operating with the possibility of operator's manual action, or the above driving gear is made with the possibility of operator's manual action directly to the lid.

At that, the spot above the mixing chamber 2 corrugated side wall 11 or the spot above the precipitation chamber 7 corrugated side wall 12 were chosen as the operator's action application spot (Fig. 1 и 4).

Furthermore, in case of constructive performance of the bottom 3 of the mixing chamber 2 and of the bottom 10 of the precipitation chamber 7 with the capacity of rotation, the above bottoms are fixed on the interchamber partition (wall 6) via the

hinges 32 (Fig.5), providing the possibility of each bottom rotation in the respective chamber lid rotation plane. At that, in order to avoid a non-sanctioned turn of the bottom, the hinges 32 are equipped with locking screws (not shown in the Fig.).

Configuration of the corps formed by the mixing chamber 2 and the precipitation chamber 7, in plane, can be performed in the form of e.g. either rectangular shape with rounded corners, (not shown in the Fig.), or as a circle (Fig. 6), or as an ellipse (Fig. 7), or as a figure-of-eight (Fig. 8).

The biological fluid correction system operates the following way:

Periodical, with the frequency depending on e.g. rotational speed of the disc 31, or on the frequency of pressing the lid by e.g. operator, rotational action of the driving gear to the lids 4 and 8, respectively, of the mixing chamber 2 and the precipitation chamber 7, changes capacities of the above chambers with the same frequency, as well as it changes capacity of the vessel 1 placed in the inner cavity of the mixing chamber 2. Such change of capacities, correspondingly, changes pressure inside the chambers and the vessel, increases it at capacity reduction, and reduces at capacity increase, and in consequence, the respective biological fluid is periodically soaked into the correction system, which is connected with e.g. patient's blood-vascular system, or just with a reservoir containing a biological fluid (not shown in the Fig.), and is output after being corrected, correspondingly into the patient's blood-vascular system or into a special reservoir.

Here the biological fluid, e.g. blood from the patient's vein, simultaneously gets into the vessel 1 which is preliminarily filled up with ferreed sorbent, and into the

mixing chamber 2 through the respective channels due to the driving gear action directed to increase the vessel 1 and the mixing chamber 2 capacities, in the amount proportional to the respective capacity change value. The blood getting into the vessel 1 makes a respective suspension with the ferreed sorbent already sitting in the vessel, then the above suspension amount commensurable to the value of the vessel capacity reduction (resulted by the driving gear action) gets into the mixing chamber 2 through the channel 19, where the ferreed sorbent of the above suspension is mixed and interacts with the blood preliminarily entered into the above chamber, while absorbing respective toxic impurities, (refer to e.g. above specified) International Bid № PCT/RU94/00022. The entering biological fluid flow/jet swirl, (happening) due to the blood input under the above mentioned angle with respect to the mixing chamber bottom 3 and the walls 6 and 10, expedites intensive immixture of the above blood with the ferreed sorbent in the mixing chamber 2. It should also be pointed out, that that the part of the biological fluid which enters into the vessel 1 for composing a suspension with the ferreed sorbent, does also interact with the above sorbent, however, the concentration of the sorbent in the suspension, as well as the treating capacity of the above sorbent connected with its amount, significantly exceeds any losses for that interaction process.

At the mixing chamber 2 capacity reduction and the respective increase of the capacity of the precipitation chamber 7, the purified blood suspension with the ferreed sorbent goes through the channel 20 into the precipitation chamber 7, where the ferreed sorbent is precipitated under the influence of magnet field in the zone of placement of magnets 13, and the purified blood at the following reduction of the chamber 7 capacity

goes through the channel 21 into the filtering device 22, after going thorough the filtering device 22, the blood can be respectively injected into the patients blood-vascular system.

In case if the system pressure is not sufficient for biological fluid running through the filtering device 22, e.g. a pump of e.g. peristaltic type e.g. installed in the system output channel 23 can be used as well (not shown in the Fig.).

INDUSTRIAL APPLICABILITY

The proposed performance of the biological fluid correction system provides the possibility of biological fluids quality purification without using any additional reagents, e.g. through using ferreed sorbent with no physiological solution, and besides, it allows to significantly minimize the system dimensions without any decrease of useful capacities of both chambers and the vessel as well as it allows to simplify the construction factually providing the possibility to make disposable systems, that enables using the propose biological fluids correction system not only in clinical conditions, but also in conditions of ambulance and emergency, e.g. in emergency/disaster medicine.